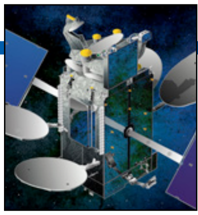
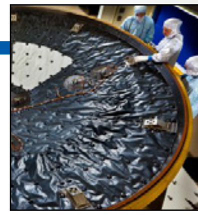
National Aeronautics and
Space Administration

Technology Demonstration Missions Program

The Bridge

Fall 2015




Q&A: Meet TDM Program Executive Trudy Kortes

Trudy Kortes, NASA program executive for TDM. (Photo: NASA/GRC)

NASA TDM Program Executive Trudy Kortes was named to her post in August. "Bridge" editor Rick Smith recently sat down with Kortes to discuss the program and her expectations for it, and TDM's key role within the Space Technology Mission Directorate, which sponsors the program.

Kortes is a 1991 graduate of the University of Michigan in Ann Arbor, where she earned her bachelor's degree in aerospace engineering. She went on to receive her master's degree in environmental engineering in 1995 from the University of Houston in Texas. Her professional career started in 1991 at Lockheed Engineering and Sciences Company in Houston, where she worked as a thermal vacuum test conductor and director of various aerospace systems, space shuttle and International Space Station hardware. She joined NASA's Johnson Space Center in Houston in 1994 as an environmental engineer tasked with enforcing air emissions compliance programs. In 1996, she moved to NASA's Ames Research Center in Moffett Field, California, where she became program manager for the National Environmental Policy Act, or NEPA.

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Green Propellant Project Passes Critical Milestone, Readies for 2016 Launch

From a NASA news release

The propulsion subsystem for NASA's *Green Propellant Infusion Mission* has been integrated onto the spacecraft, moving the mission–the first green-propellant mission flown by NASA–another major step toward its scheduled launch in 2016.

GPIM prime contractor Ball Aerospace & Technologies Corp. in Boulder, Colorado, was able to integrate the green propellant propulsion subsystem in less than two weeks after receiving it from Aerojet Rocketdyne in Redmond, Washington. The propulsion subsystem will be the primary payload on the mission's spacecraft–a Ball Configurable Platform 100 small satellite. System performance and environmental testing are underway.

The mission will demonstrate the practical capabilities of a hydroxyl ammonium nitrate-based fuel/oxidizer propellant blend, known as AF-M315E, developed by the U.S. Air Force Research Laboratory at Edwards Air Force Base in California. It offers higher performance but is safer to handle and "greener"–easier on the

A Ball Aerospace engineer adjusts the thermal insulation on NASA's Green Propellant Infusion Mission spacecraft bus following integration of the propulsion system. (Photo: Ball Aerospace)

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Green Propellant Project Passes Critical Milestone, Readies for 2016 Launch...*continued from p. 1*

environment–than traditional chemical fuels such as hydrazine currently used in spacecraft thrusters. It also requires fewer handling restrictions and has potentially shorter launch processing times, resulting in reduced costs.

Because the new propellant provides improved performance and volumetric efficiency compared to hydrazine, more of it can be stored in propellant tanks of the same volume, resulting in a 50-percent increase in spacecraft maneuvering capability for a given volume. It also has a lower freezing point than hydrazine, requiring less spacecraft power to maintain the propellant temperature. These characteristics make it ideal for a wide range of emerging small, deep-space satellite missions.

"NASA is always looking for new technologies that also allow us an opportunity to improve safety and cost efficiency," said Trudy Kortes, Technology Demonstration Missions program executive at NASA Headquarters in Washington. "GPIM additionally affords us an opportunity to test an environmentally friendly fuel in space for the first time and there's nothing more rewarding than a trailblazing mission."

The GPIM propulsion subsystem on the satellite will be loaded with the AF-M315E propellant before launch. During the 13-month mission, researchers will conduct orbital maneuvers to demonstrate the performance of the propellant during attitude control shifts, changes in orbital inclination and orbit lowering.

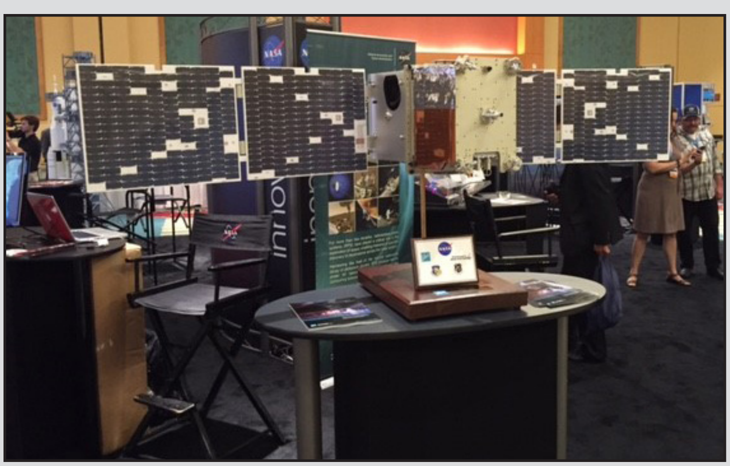
"GPIM is the key mission to demonstrate a green monopropellant alternative to hydrazine," said Jim Oschmann, Ball Aerospace vice president and general manager of civil space and technology. "Everyone in the industry, from NASA to our industry partners to green propellant suppliers, is eager to see 10 years of American-led research and development realized with this spaceflight mission."

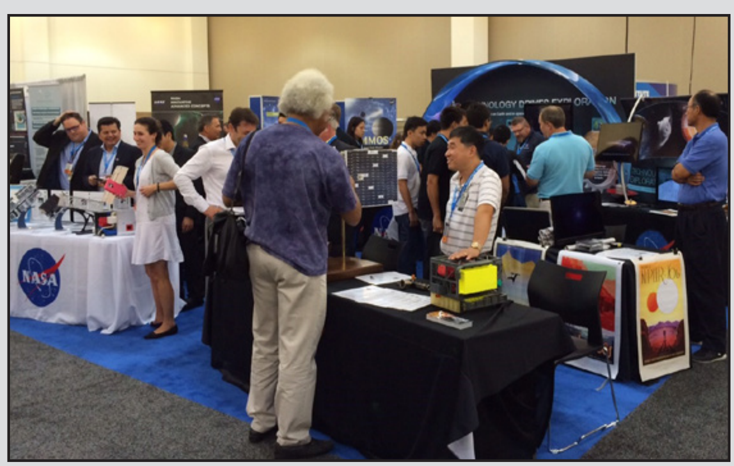
Three U.S. Department of Defense experimental payloads will also fly aboard the GPIM spacecraft, which is scheduled for launch to low-Earth orbit in 2016 in partnership with the Army Space and Missile Defense Command. Additional team members include the Air Force Space and Missile Systems Center at Kirtland Air Force Base, New Mexico; NASA's Glenn Research Center in Cleveland, Ohio; NASA's Goddard Space Flight Center in Greenbelt, Maryland; and NASA's Kennedy Space Center, Florida.

The GPIM mission is part of a portfolio of technology flight and ground demonstration projects led by NASA teams and industry partners across the country and managed by the TDM program office at NASA's Marshall Space Flight Center in Huntsville, Alabama. The program is sponsored by NASA's Space Technology Mission Directorate in Washington.

TDM Participates in AIAA Shows

NASA's TDM projects are prominently on display at a pair of American Institute of Aeronautics and Astronautics conferences. At left, a Green Propellant Infusion Mission model awaits the day's visitor traffic at the AIAA Propulsion & Energy Forum held in July in Orlando, Florida. At right, NASA engineer Yong Chong of the Deep Space Atomic Clock team at NASA's Jet Propulsion Laboratory in Pasadena, California, discusses the DSAC project with a visitor at the AIAA Space 2015 conference held in August in Pasadena. Steve Jurczyk, associate administrator of the Space Technology Mission Directorate, was a panel speaker at Space 2015 and also addressed visiting high school students about the benefits of pursuing a strong education in the STEM fields: science, technology, engineering and mathematics. The GPIM project, led by Ball Aerospace & Technologies Corp. of Boulder, Colorado, was on display at both events, while the Solar Electric Propulsion project, headed by NASA's Glenn Research Center in Cleveland, also was showcased at the Propulsion & Energy Forum. (Left photo: GRC/Rich Rinehart; right photo: MSFC/Keyke Reed)





Innovative 'HERMeS' Thruster Offers Critical Solar Electric Propulsion Advances

An objective of the Solar Electric Propulsion project – one of the newest Technology Demonstration Missions sponsored by NASA's Space Technology Mission Directorate – is to develop and demonstrate high-power SEP technology in the relevant space environment, thereby enabling spacecraft that use electric propulsion for primary propulsion and can deliver payloads from low-Earth orbit to higher orbits.

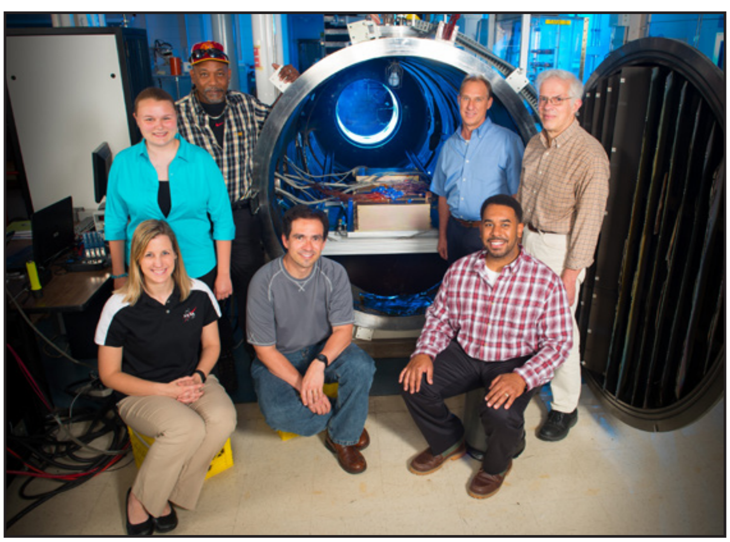
Critical to NASA's space exploration agenda, high-power solar electric propulsion is recognized as a cornerstone of NASA's journey to Mars, and thus the TDM project is of vital importance to the agency's plans. Specifically, the technology is part of NASA's Proving Ground missions, intended for use in moving large cargo across interplanetary space as part of a multi-use, evolvable space infrastructure. A key element of high-power SEP is longer-lifetime thrusters, to which the SEP project propulsion team incorporated novel magnetic shielding into a Hall thruster technology development unit.

Dubbed the Hall Effect Rocket with Magnetic Shielding, or HERMeS, the technology development unit was designed and modeled by a team of researchers from NASA's Glenn Research Center in Cleveland, Ohio, and NASA's Jet Propulsion Laboratory in Pasadena, California, and fabricated at Glenn. The HERMeS TDU-1 was designed and fabricated to evaluate the design and challenges of the next evolutionary step in power levels and thrust capability for Hall Effect Thruster technologies. The key performance parameters associated with this next evolutionary step – which HERMeS has successfully demonstrated – is a 12.5 kW, magnetically shielded, 3,000-second specific impulse Hall thruster, prior to transitioning the technology to industry.

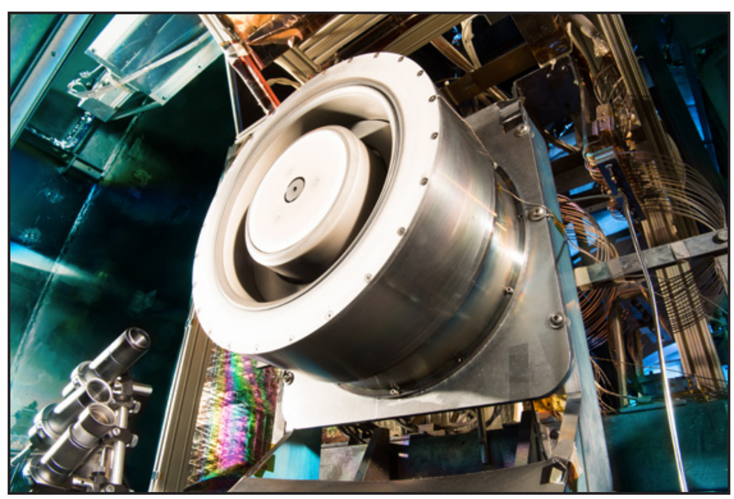
HERMeS incorporates technologies developed by NASA over nearly two decades, and is enabled through the use of magnetic shielding to effectively eliminate discharge chamber erosion. It is unique because it is the first Hall thruster designed for magnetic shielding over its entire service life. The result is a significant increase in its operational lifetime as compared to current, state-of-the-art Hall thrusters, extending its service life from approximately 8,000 hours to more than 50,000 hours. In addition, HERMeS demonstrated a discharge power three times greater than that of current Hall thrusters, with twice the discharge voltage and seven times greater propellant throughput.

Since mid-2015, the SEP team evaluated HERMeS' thruster performance, confirmed its magnetic shielding, characterized its thermal operation and assessed its operational stability, using vacuum facilities at Glenn. Performance characterization tests determined that the unit achieves a peak thruster efficiency of 64 percent at 12.5 kW and can attain a specific impulse of 3,000 seconds at 12.5 kW, at a discharge voltage of 800 volts – which is double the energy and acceleration of prior state-of-the-art thrusters.

HERMeS is directly infused into TDM. The data analysis of TDU-1 is being used to update the Solar Electric Propulsion project's mission design and to validate models for the mission application – part of the Asteroid Redirect Robotic Mission. Furthermore, insights gained in this activity have provided invaluable lessons learned in thruster development, reducing future risk for the HERMeS design, as NASA works with industry to develop qualification and flight units employing these high-power solar electric propulsion thrusters.



Showing off the Hall Thruster high-power 120/800v power processing unit during vacuum-chamber testing at NASA's Glenn Research Center in Cleveland are, seated from left, Karin Bozak, PPU test lead engineer; Walter Santiago, PPU product lead engineer, and Henry Fain, test engineer; and standing, from left to right, Susanah Kowalewski, engineering summer intern; Danis Arthur, engineering technician; Michael Capelety, quality assurance lead; Arthur Birchenough, PPU electrical engineer. (Photo: NASA/GRC)



The HERMeS TDU-1 undergoes testing to validate design methodology and tools and to reduce mission and flight hardware development risks in Vacuum Facility 5 at Glenn Research Center. (Photo: GRC/Michelle Murphy)

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This role led her to NASA Headquarters, where Kortes joined NASA's Professional Development Program. In 2002, she moved to NASA's Glenn Research Center in Cleveland, Ohio, where she managed Glenn's NEPA program until 2006. Since then, she has supported and managed elements of programs as diverse as the Orion crew module, designed to carry explorers on new missions of discovery to Mars and other solar-system destinations; Glenn's Radioisotope Power Systems Program Office, investigating nuclear power technologies to enable future space exploration missions; and the Cryogenic Propellant Storage & Transfer project, an early TDM initiative recently retitled the Evolvable Cryogenics project, or eCryo. Most recently, Kortes was chief of the Space Technology Project Office at Glenn from 2011 to 2015, before taking on the TDM program executive role.

What are your goals and expectations for the TDM Program?
First, as part of STMD, it's our goal to get these technologies over the finish line. We're kind of a last step before we hand them off for actual use. Second, I'm determined to help us develop the right technologies at the right time to serve the needs of our customer base inside and outside of NASA, including the agency's key organizations–the Human Exploration and Operations Mission, the Science Mission Directorate–and commercial aerospace interests as well. We have to go cautiously; there are limitations to what we can do, including budget, so we have to be very judicious about how we spend our money and when.

What are TDM's strengths? What makes it valuable to NASA?
By far, the strength of TDM is the outstanding people who work in the organization–both in the program office and at the project level. I cannot say enough good things about the hard work, the diligence, the attention to detail and the exceptional project management skills demonstrated every day by these folks. The pace and intensity of the projects, the dynamic environments they work in and the issues that come up are often things we've never dealt with before, yet TDM teams handle them deftly. It's like running a marathon at a sprint pace. It never ceases to amaze me–the innovation and brilliance of the people who work on these projects for the agency! This is a vital and successful multi-center program, with all the camaraderie and collaboration that goes along with that.

What also makes TDM so valuable is its *de facto* role as a research and development arm for the agency. It reminds me of a commercial firm's R&D fund. NASA has countless programs and projects around the country, all trying to make progress with what's available, with what's on the shelf in terms of state of the art. They're on a deadline; they don't have the time to devote to innovation. So *we* do this work to keep them focused on their primary purpose, which is to see that project to completion. We can innovate on their behalf.

What are the primary challenges the program faces?
Budget and funding are big challenges. There's more on our list of things that need to be done than there is the money to do them. That's the nature of this work, and we recognize that. We always hope we'll get what we need–or closer to what we need–but we live in a very realistic, practical world, and we achieve great things anyway, on time and when our customers need it, in spite of tight funds and tight schedules.

How valuable are partnerships to TDM's success?
Here's an area where TDM is *really* valuable, inside and outside NASA. Partnerships aren't just a good idea anymore; they're vital. They're critical. They're also a requirement: Every project in TDM must be 25-percent funded

Kortes, right, leads a group of NASA VIPs including NASA Associate Administrator Robert Lightfoot, second from left, and Deputy Associate Administrator Lesa Roe, fourth from left, on a tour of Solar Electric Propulsion testing in Vacuum Facility 5 at NASA's Glenn Research Center in Cleveland. (Photo: NASA/GRC)

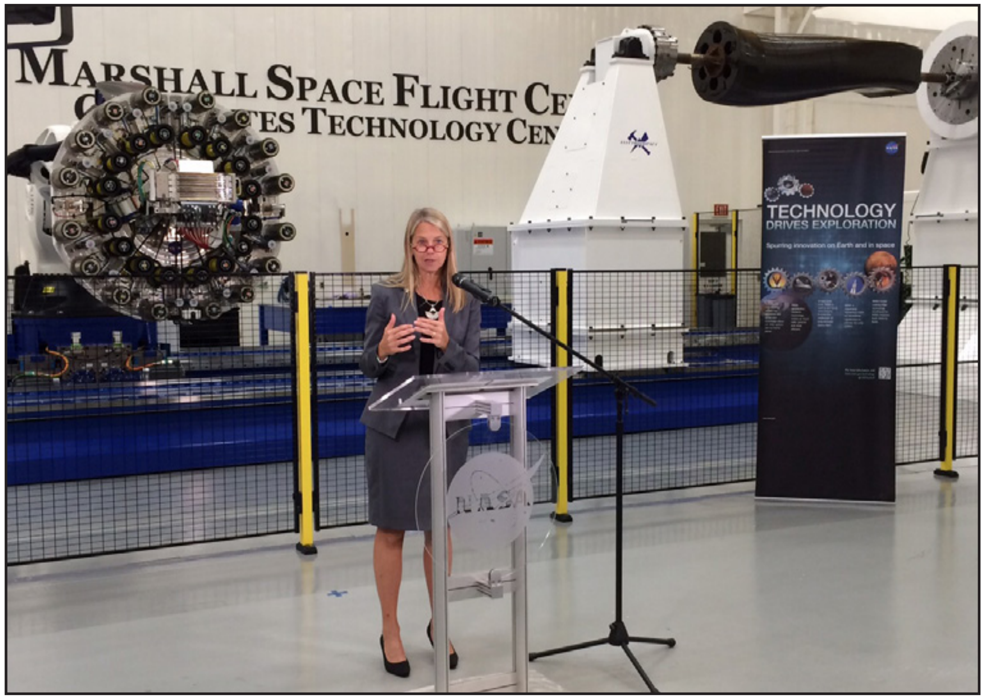
by other sources. That drives so much of what we do, with our various partners seeking to infuse TDM technologies into a variety of missions and architectures, into various product lines, complementing NASA's concepts and goals with practical applications that help guide development. We're not building bridges to nowhere; we can't afford it. We look to our partners to help forge the path, networking, bouncing ideas off each other. This is hugely important to how things progress, how we keep up to date with what's going on across industry. These relationships are crucial to NASA's future success.

How would you sum up your philosophy of leadership?
It might sound a bit corny, but I keep a quote handy from Coach Bo Schembechler of the University of Michigan, my alma mater. It resonates with me. He said, "No man is more important than the team. No coach is more important than the team. The team, the team, the team." I'd apply that to NASA and say that no leader is more important than the team, and no individual is more important than the team. I really believe that. We all have critical jobs to do, and working together as a team, we will get them done.

TDM team members and other NASA and industry personnel can contact Kortes at trudy.f.kortes@nasa.gov.

http://www.nasa.gov/mission_pages/tdm/main

NASA Deputy Administrator Dava Newman Inspects New CEUS Tool



NASA Deputy Director Dava Newman speaks to members of the Huntsville, Alabama, media during her August visit to NASA's Marshall Space Flight Center in Huntsville. Among the key Marshall facilities and laboratories Newman toured was the Automated Fiber Replacement Tool in Marshall's Composites Technology Center. Newman was joined by John Vickers, manager of the Composites for Exploration Upper Stage project, or CEUS, to talk about the revolutionary new tooling machine, which is expected to help the TDM project achieve dramatic results in fabricating lightweight, advanced composites for the design, construction and testing of large launch vehicle composite dry structures scaled for use on NASA's Space Launch System Exploration Upper Stage. (Photo: MSFC/Keyke Reed)

Hands-on TDM at Gulf Coast Exploreum

Five-year-old Frank Smith of Fairhope, Alabama, conducts a small-scale deceleration experiment reminiscent of the Low Density Supersonic Decelerator project during "NASA Lands and the Exploreum Day" in August at the Gulf Coast Exploreum in Mobile, Alabama. Cohosted by NASA's Marshall Space Flight Center, the event included agency exhibits showcasing TDM, the Space Launch System and the Discovery and New Frontiers Programs. Approximately 750 visitors toured the Exploreum, talked with NASA team members and browsed exhibits. (Photo: al.com/Mike Kittrell)

Supersonic Decelerator Wows Crowds at JPL Open House

NASA guidance and control engineer Clara O'Farrell, at right center, talks with visitors at NASA's Jet Propulsion Laboratory in Pasadena, California, about the role of a fully deployed Supersonic Inflatable Aerodynamic Decelerator–like the one she's standing inside–in slowing down a space vehicle during entry and descent above Mars or a similar planet. The SIAD is an advanced aerobraking technology being tested as part of NASA's Low Density Supersonic Decelerator project; full-scale, suborbital testing was conducted off the coast of Hawaii in 2014 and again in 2015. JPL showed off the technology, along with a variety of other science and spaceflight projects and mission hardware, during an open house in October, which drew an estimated 45,000 visitors. The LDSD team continues to assess the data from the 2015 flight. Such technologies–key goals of the TDM program–could transform robotic and human precursor missions to the Red Planet. (Photo: NASA/JPL)

NASA engineer Monica Guzik. (NASA/GRC)

Editor's Note: TDM Bridge Builders are team members at NASA centers and partner organizations who are helping bridge the gap, bringing one of our cutting-edge technologies to flight readiness. Got a suggestion for a TDM teammate worthy of the spotlight? Email richard.l.smith@nasa.gov.

Monica Guzik is deputy product lead engineer for the Evolvable Cryogenics project's Integrated Vehicle Fluids task at NASA's Glenn Research Center in Cleveland, Ohio. In addition to her work on eCryo, she supports aerospace technologies activities at Glenn as a gas and fluids systems engineer within the Propulsion Division's Fluids and Cryogenic Systems Branch, where she regularly serves as a product lead engineer, performing modeling, analysis and design work on a variety of fluids-related technologies.

A native of Avon, Ohio, Guzik interned at Glenn for three consecutive summers starting in 2007, after her freshman year at Rose-Hulman Institute of Technology in Terre Haute, Indiana. After graduating from Rose-Hulman in late 2010 with a bachelor's degree in chemical engineering, she accepted a full-time position in Glenn's Fluids Systems Branch. An avid athlete and music lover, Guzik also makes time to play adult-league soccer and stays abreast of Cleveland's legendary rock-and-roll scene. She talked recently with *The Bridge* about her work in TDM, her role at Glenn and the other passions that shape her life.

What are your responsibilities on eCryo?

As deputy product lead engineer, or PLE, for eCryo, I work closely with Arthur Werkheiser, the eCryo lead engineer at NASA's Marshall Space Flight Center in Huntsville, Alabama, to lead our cross-center team of engineers and technicians in modeling and testing the integrated vehicle fluids, or IVF, system technologies developed by United Launch Alliance in Denver, Colorado. We are working to assess the IVF technologies for potential application on the Space Launch System's Exploration Upper Stage by demonstrating it in a subscale test at Marshall. In addition to project management, I am involved in both technical leadership and engineering analysis, which I find to be a challenging and rewarding combination. The deputy PLE role blends engineering skills with interpersonal relationships, and I really enjoy it.

What else do you do at NASA? How has that work prepared you for eCryo?

Here at Glenn, my main areas of focus are cryogenics systems and non-flow-through, proton exchange membrane, or PEM, fuel cell power systems. In cryogenics, I've worked on a variety of technologies, including active thermal control, cryocoolers, insulation, tank chilldown behavior, autogenous tank pressurization and cryogenic transfer operations. My background in power systems and experience with cryogenic technologies has given me a unique mix of skills and knowledge to bring to my role on eCryo, considering how IVF blends cryogenic boil-off management with the power, thrust, and pressure control requirements of a vehicle upper stage. It all falls into my areas of expertise.

As a NASA employee, I'm also passionate about community outreach, particularly engaging our next generation of engineers, scientists and technicians in the STEM career fields–science, technology, engineering and mathematics. I've been lucky enough to work with the excellent education and outreach teams here at Glenn on a number of STEM activities. In 2014, I was the chairperson for NASA's Thermal and Fluids Analysis Workshop, a conference sponsored by the NASA Engineering & Safety Center, which unites the international thermal and fluids analysis community for a week-long workshop featuring short courses, paper sessions, NASA tours and networking events.

How do you hope your contributions and your work will impact NASA's TDM goals?

In order for NASA to achieve its mission to Mars, it is imperative that we have enough propellant in our tanks to get us there and back safely while still saving as much mass as possible. Effective management of our propellant, whether by using the boil-off for other purposes in the system or by using thermal control to manage the heat leak–or the amount of heat transferred into the contents of a vessel under standard ambient conditions–is critical to reaching our next destination. IVF technology development seeks to do the former, using the tank's preexisting boil-off to produce power and thrust while also controlling tank pressure.

By testing and modeling this concept for a NASA application such as SLS's Exploration Upper Stage, NASA is gaining valuable insight that will benefit upper stage designs in the future. By further demonstrating this technology in a real-world application, we can open doors to effectively reducing mass and system complexity, thereby getting us another step closer to safely reaching and returning from the Martian surface.

What do you hope most to accomplish on the eCryo project?

Our team is hoping to provide a realistic set of validated models to help assess the IVF technology concept for future NASA applications, with the Exploration Upper Stage being the primary focus. We want to show that effective use of cryogenic boil-off has widespread benefits for future upper stage designs. When the next-generation upper stage takes our astronauts to Mars, I'll know our team helped

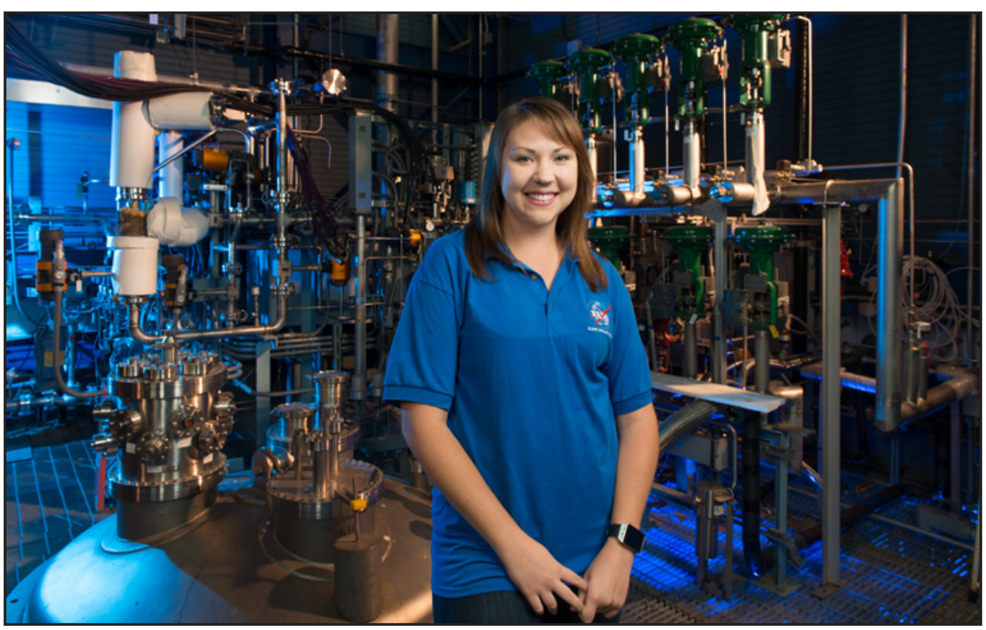
STMD Tackles San Diego Comic Con

NASA team members talk space exploration, technology and the journey to Mars with thousands of visitors at San Diego Comic Con, held in July in San Diego, California. The agency's Space Technology Mission Directorate, which sponsors the Technology Demonstration Missions program, joined other key agency organizations in acquiring booth space for the first time at the 2015 show. Held annually at the San Diego Convention Center, Comic Con draws more than 150,000 registered attendees per day for five days each summer, and is a major draw for fans of science, technology, pop culture and entertainment. Joining NASA were exhibitors from AMC Network, DC Entertainment, Fox Network, Hasbro, Lego, Marvel Entertainment and many more. (Photo: MSFC/Dominique Cavanaugh)

define and advance the technologies on board. On a personal level, I'm also excited to work with such a great team, in a role that I really enjoy. I believe in learning something new every day–and this project certainly delivers!

Tell us about your first NASA job…
During my freshman year at Rose-Hulman, I found out about the Lewis' Educational and Research Collaborative Internship Project at Glenn. I spent the summer of 2007 testing alternative fuel cell thermal control concepts for Glenn's Electrochemistry Branch. I returned to the branch in the summers of 2008 and 2009, and took a co-op position in the spring and summer of 2010. The work instilled in me a passion for NASA and the thermal/fluids discipline, so when I graduated from Rose-Hulman in November 2010, I accepted a full-time position within the Fluids Systems Branch, where I still work today.

What's one thing most people would be surprised to learn about you?
I played varsity soccer for the Rose-Hulman Fightin' Engineers. We had an excellent team, and went to the NCAA tournament my sophomore year. I still play three to four times a week in various co-ed leagues. I'm very competitive, so soccer is a great way to positively channel that energy while staying healthy and having fun.



Guzik shows off research facilities in Glenn Research Center's Fluids and Cryogenic Systems Branch. (NASA/GRC)

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